

REMARKS

The claims pending in this Application are claims 1-27 and 32 with claims 13 and 24 being allowed. Claims 1, 14, 26, and 27 have been amended. Claims 28-31 are cancelled. Claim 32 is newly added. In the Final Office Action, claims 1, 14, 26, and 28 stand rejected under 35 U.S.C. § 112, first and second paragraphs. In particular, the Office Action objected to describing the reaction zone as being “substantially sealed” from the deposition zone. In addition, claim 26 was rejected for including the limitation of the depressurized deposition zone having a pressure of less than 10^{-5} Torr. In order to advance prosecution of this case, and without conceding the propriety of the rejections, independent claims 1, 14, and 26 have been amended to remove the “substantially sealed” aspect of the claims. In addition, claim 26 has been amended to remove the objected to pressure limitation of the deposition zone.

Independent claims 1 and 14 have been amended to include the feature wherein the reaction zone is free of oxygen. Support for this feature may be found, for example, in the specification at ¶ [0055]. Claims 1 and 14 relate to method of forming MgB_2 films *in-situ*. Any oxygen present in the reaction zone will form MgO which will contaminate the MgB_2 films. For this reason, the reaction zone should be free from an oxidizing species such as oxygen. Claim 26 has been amended to recite a method of forming a thin film of a known compound *in-situ*. Claim 26 has also been amended to recite that one element of the compound is metallic and heated to produce a pressured gas inside a reaction zone. Support for this feature may be found, for example, in the specification at ¶ [0042] (magnesium evaporation cell used to heat solid magnesium) and ¶ [0043] (placing source of magnesium directly inside reaction chamber).

Turning to the prior art rejections, claims 26, 28-31 stand rejected under 35 U.S.C. §§ 102(a/e) as being anticipated by U.S. Patent No. 6,527,866 (Matijasevic et al.). Alternatively, these same claims are rejected as being obvious over Matijasevic et al. Claims 1-12, 14-23, 25, and 27 stand rejected as being obvious over Matijasevic et al. in view of U.S. Patent No. 6,626,995 (Kim et al.).

In response to the rejection of the claims based on the cited prior art, claims 1 and 14 have been amended to recite a method of forming MgB_2 films *in-situ* using a method that moves a substrate between a single deposition zone (for boron deposition) and a single reaction zone containing pressurized gaseous magnesium that is free of oxygen. As explained above, in the formation of MgB_2 it is extremely important that the reaction chamber be free from oxygen (or other oxidizing species) because its presence will contaminate the *in-situ* formed thin film of MgB_2 . Claim 26 has been somewhat similarly amended in that the method forms a compound using a reaction zone containing a pressurized metallic element of the compound. None of these features are disclosed or suggested in either Matijasevic et al. or Kim et al.

As part of this submission, Applicants have also submitted a Rule 1.132 Declaration from Dr. Todd Kaplan (hereinafter "Kaplan Decl. at ¶__") – a listed inventor on the Matijasevic et al. U.S. Patent. Importantly, Dr. Kaplan has reviewed the pending set of claims, relevant portions of the Final Office Action, the Matijasevic et al. and Kim et al. references, and has concluded that the claimed method of forming a superconducting compound such as MgB_2 would not have been obvious in light of his own patent.

Turning now to the prior art references, Matijasevic et al. discloses a device and method for forming "multi-component" superconducting thin films. Matijasevic et al. does

not, however, disclose the use of a pressurized, metallic species within the reaction zone.

The use of a heated metallic species within a pressurized reaction zone is not contemplated by Matijasevic et al. and, importantly, Dr. Kaplan agrees that charging the reaction zone with a pressurized metallic species is not an obvious modification to the method and device disclosed in the Matijasevic et al. patent. Kaplan Decl. at ¶ 7.

Importantly, the device and method disclosed in Matijasevic et al. are largely directed to the formation of superconducting compounds having an oxidizing constituent therein. For example, Matijasevic et al. describes a vessel (102) that includes at least two deposition zones (116) and at least one reaction zone (118). Each deposition zone typically contains a metallic species while the reaction zone contains an oxidizer. See Col. 6, lines 22-33 and Col. 8, lines 17-28. There are several important distinctions between Applicants' claimed method and that employed in Matijasevic et al. First, an important distinction between Applicants' claimed method and that disclosed in Matijasevic et al. is the use of an oxidizer compound in the reaction chamber. An oxidizer such as oxygen is anathema to the formation of MgB_2 because, as stated herein, oxygen combines with magnesium to form MgO which will contaminate the thin film rendering the same useless. Yet Matijasevic et al. discloses a device that uses a reaction zone that is designed to contain a gaseous oxidizer. Nowhere does Matijasevic et al. disclose or suggest introducing a metallic species into the thin film via the reaction chamber – instead Matijasevic et al. discloses using multiple separate deposition zones for introducing the metallic species. Among other changes, one would have to modify the device of Matijasevic et al. to include the capability to introduce a metallic species into the reaction zone (e.g., add evaporation cell for metallic species that is connected to reaction chamber)

– something that Dr. Kaplan acknowledges is not something that was contemplated or an obvious modification. Kaplan Decl. at ¶¶ 7-9. In addition, in the thin films made in Matijasevic et al. there is a need to carefully control the relative amounts of metallic species in the final compound. Because of this, the method used in Matijasevic et al. relies on heated metal strips, e-gun evaporators, and effusion cells that are used in conjunction with deposition monitors to carefully monitor and control metallic deposition rates. See e.g., Col. 6, lines 22-27 and Col. 7, lines 20-40 (illustrating use of QCM deposition monitors).

Unlike the carefully controlled deposition of metals as disclosed in Matijasevic et al., Applicants' claimed method does not need the expensive and sometimes cumbersome deposition monitors because MgB_2 has adsorption limited growth. That is to say that so long as enough magnesium is present within the reaction zone, the correct composition forms and excess magnesium simply does not form in the *in-situ* film. Not only is this an added benefit, it also shows why one skilled in the art would not modify the device or method of Matijasevic et al. to deposit metallic species within the reaction zone (118). Kaplan Decl. at ¶ 8.

A related point of distinction between Applicants' claimed method and that disclosed in Matijasevic et al. is that in Applicants' method, the metallic vapor (e.g., magnesium) in the reaction zone improves the sealing capability between the reaction zone and the deposition zone by condensing and "gettering" any oxidizing species that pose a threat to newly formed *in-situ* film. In this regard, by using the metallic species in the reaction zone, this acts as seal to prevent oxidizing species (e.g., oxygen) from **entering** the reaction zone. In Matijasevic et al., however, to the extent there is a concern with sealing the reactant zone from the deposition zone, it is concerned with preventing reactant gas (e.g.,

oxidizing species) from **exiting** the reactant zone into the deposition vessel. See Col. 8, lines 40-46. The concern in Matijasevic et al. is what enters the deposition vessel not what enters the reaction zone.

Turning now to the Kim et al. reference, this reference is also different from Applicants' claimed method for a number of reasons. First, Kim et al. discloses a method in which a template film having a hexagonal structure is first deposited on a substrate. See Abstract and Col. 2, lines 49-56. Applicants' method does not utilize a template as the MgB_2 is grown directly on the substrate *in-situ*. In addition, in the Kim et al. method, a superconductive film is epitaxially grown by using a target of MgB_2 using a sputtering, pulsed laser deposition, or e-beam evaporation. Col. 4, lines 40-46. Kim et al. is entirely devoid of any teaching or suggestion of using a high temperature, pressurized reaction zone containing magnesium to form MgB_2 *in-situ* on a substrate. Rather, Kim et al. concerns the use of rather **conventional, epitaxial methods** of forming thin films. Kim et al. also discloses that the method may need post-annealing processing if, for example, the amount of magnesium in the thin film is insufficient. See Col. 4, lines 5, lines 20-41. Still other methods require a passivation film disposed on amorphous MgB_2 followed by a post-annealing process. Applicants' method does not require any passivation film or post-annealing process.

Kim et al. thus concerns a rather conventional epitaxial method of forming MgB_2 which may require a template layer and post-annealing to achieve the desired film stoichiometry. There is no suggestion of using a pressurized source of metal that successively encounters a substrate that moves in and out of a reaction zone and deposition zone. Whatever teachings contained in Kim et al. are not relevant to the method

disclosed in Matijasevic et al. (or as claimed in the present Application) because Kim et al. relates, for the most part, to conventional epitaxial methods of producing thin films. There is no indication or suggestion contained in Kim et al. that would suggest modifying the device or process of Matijasevic et al. to include a single reaction zone that contains gaseous metallic species separated from a distinct deposition zone. Indeed, the declaration provided by Dr. Kaplan confirms this to be the case.

In light of the amendments and remarks made herein, Applicants believe that the pending claims are allowable over the prior art of record. The Application should be in condition for allowance. If there are any questions concerning this submission, please contact the undersigned at (949) 677-7758.

Respectfully submitted,
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Dated: July 17, 2007

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